SHOCK ABSORBER SYSTEM ADJUSTMENT DEVICE

[0001] This application claims the benefit of U.S. Provisional Application No. 60/461,373 filed April 10, 2003.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to a device for turning a threaded nut, and more particularly to a device for adjusting automotive shock absorber systems with adjustable coil spring mountings.

[0003] In a typical automotive shock absorber system, the upper end of the shock absorber is secured to the vehicle's frame or chassis and the lower end is secured to a wheel control arm or related part of the vehicle's suspension. In one form, called a coil-over shock arrangement, the system includes a cylindrical shock absorber body having features for the mounting of a resilient coil spring therearound. A piston inside the shock absorber body is connected to a piston rod such that the piston and rod move in response to up or down movement of the wheel relative to the shock absorber body in a telescoping fashion. The coil spring is compressed between seats (also known as spring perches) that are affixed to the piston rod and the shock absorber body, respectively. Together, the spring and shock absorber suspend the vehicle and act to level the vehicle during certain maneuvers, as well as dampen out loads imparted to the vehicle from undulations in the surface upon which the vehicle is riding.

[0004] In a typical passenger vehicle application, the shock absorber configuration is either fixed (such that the ride height and relative stiffness are relatively constant within a given shock absorber and spring combination) or are adjustable through electromechanical means (such as driver-controlled ride-adjustment componentry). Neither of these approaches are acceptable for vehicles configured for racing, where slight differences in the suspension setup can mean the

difference between winning and losing. The conditions of race tracks and race cars, both of which can be dependent upon environmental conditions, and can change over the course of a race, necessitate that quick, precise spring perch adjustments be made within a limited amount of time, most notably during practice or a pit stop during the race. The relatively fixed nature of the conventional passenger vehicle shock absorber system is such that adjustment can only be achieved when the vehicle is removed from service, which is incompatible with the fast-paced adjustments necessary in racing situations. Furthermore, due to the weight-sensitive nature of racing vehicles, any adjustable features must be incorporated without introducing significant vehicular weight or complexity. The inclusion of the aforementioned driver-controlled ride-adjustment componentry, which may include pneumatic or hydraulic actuators, conduit or the like, as well as electrical or mechanical power sources to effect such adjustment, is anathema to keeping such weight and complexity of the vehicle low.

[0005] To overcome these shortcomings of passenger vehicle shock absorber systems, racing vehicles are often equipped with adjustable coil-over shock absorber systems, where a spring perch adjustment nut (also known as a shock absorber adjustment nut or an adjustment nut) is threaded onto a portion (typically the shock absorber body) of the coil-over shock assembly. By rotating the nut, the mechanic can adjust the vehicle's ride height and weight jacking, the latter to increase or decrease suspension load on a particular wheel, in response to the driver's feel and needs for the racing surface. Adjustment is effected by placing a wrench, spanner or related tool over the nut and turning it in the appropriate direction. In many vehicles, particularly race cars, the shock absorber system is relatively inaccessible, being surrounded by other vehicle components. In such circumstances, the handle of the tool that is used to improve leverage becomes a hindrance, as it can become difficult to maneuver it past other vehicle componentry to

get to the spring perch adjustment nut. In addition, once the tool is secured to the nut, the limited amount of space makes it difficult to move the tool sufficiently to re-engage the tool in the next index position to effect nut rotation. Furthermore, if the tool is misaligned with the adjustable nut and a torque is applied to the nut, the nut (which is typically of a softer material than the tool) is susceptible to damage.

[0006] Accordingly, there exists a need for a coil-over shock absorber adjustment system that can fit into relatively tight spaces to enable adjustment to shock absorber systems without having to remove the vehicle from service. Moreover, there is a need for a coil-over shock absorber adjustment system that can accommodate different sizes and configurations of spring perch adjustment nuts. There also exists a need for a coil-over shock absorber adjustment system that is easy to operate, retains portability and is resistant to wear over prolonged use.

SUMMARY OF THE INVENTION

[0007] The present invention satisfies these needs by providing a device that is very rugged and durable in its construction. According to a first aspect of the present invention, a shock absorber adjusting device includes a handle with a head coupled to it. The head defines an engaging member that is configured to couple to a spring perch adjustment nut to facilitate rotation of the nut upon application of a torque to the nut from the device. Additionally, the device includes a reversible ratcheting mechanism cooperative with the engaging member. Such a ratcheting mechanism facilitates rotation of the head to engage the nut without removal and reinstallation of the head.

[0008] Optionally, the head may be of an open-ended configuration to allow placement of the device over the shock absorber to facilitate engagement of the device and the nut. In addition, at least a portion of the engaging member defines a curvilinear race. Pawls on the

ratcheting mechanism form at least a portion of the race, thereby allowing engagement with complementary teeth on a nut or an adapter. For example, the device may further include an adapter ring configured to fit within the engaging member, where a plurality of teeth disposed around the outer periphery of the adapter ring can engage the pawls of the ratcheting mechanism to make the adapter ring rotatably responsive to rotation of the head. In one form, the adapter ring is split to facilitate its placement around the shock absorber body without having to remove shock absorber componentry. In a more particular form, the adapter ring can be split into two or more complementary parts that when assembled make up the ring-like shape of the whole. One way the parts can be made complementary is to have them formed of interlocking pieces, while another is to have a generally straight, planar interface. Appropriate joining hardware can be used to keep the split portions of the adapter ring together. The adapter ring may further include a plurality of detents projecting from one of the axial ends to give the ring a castellated shape. The detents are arranged in a predetermined pattern (such as equal spacing around the ring's periphery) so that they can fit into corresponding slots in the spring perch adjustment nut. This keyed connection promotes rotational responsiveness between the nut and the adapter ring. Furthermore, at least a portion of the plurality of detents define an aperture in them for accepting a securing pin that can in turn be used to lock the ring and nut together. The device may further comprise a hinge disposed between the head and the handle to facilitate pivotal movement between them, thereby promoting both placement and rotation of the device in tight spaces. The device is configured such that the ratcheting rotation is up to six degrees, with more particular spacing of the teeth such that the ratcheting rotation is approximately four degrees. Such a configuration could be achieved with ninety teeth disposed on either the nut or the optional adapter ring. In the present context, a ratcheting rotation is that angle subtended every time a

pawl on the ratcheting mechanism moves past a corresponding tooth on either an adapter ring or the shock absorber adjustment nut.

[0009] According to another aspect of the invention, a shock absorber adjusting wrench includes a handle with a proximal end and a distal end, a head coupled to the distal end, a hinge disposed between the handle and the head to facilitate pivotal movement between them, and a ratcheting mechanism. As before, the head includes an engaging member that is configured to couple to a shock absorber adjustment nut to facilitate reversible rotation of the nut. The head also includes a closed end disposed adjacent the distal end of the handle and an open end disposed away from the closed end. The open end is configured to allow placement of the wrench over the shock absorber body to facilitate coupling of the engaging member to the nut. Also as before, the ratcheting mechanism is cooperative with the engaging member such that upon ratcheting rotation of the wrench about the nut (which is preferably threaded along a substantially longitudinal axis of the shock absorber), the nut can be rotated, thereby effecting loosening or tightening adjustment of at least one of the shock absorber or a spring coupled to the shock absorber.

[0010] According to yet another aspect of the invention, a shock absorber adjusting assembly is disclosed. The assembly includes a wrench and a nut. The wrench includes a handle, a nut-engaging member coupled to the handle and a ratcheting mechanism cooperative with the nut-engaging member. The nut is disposable on a shock absorber to facilitate adjustment of at least one of the coiled spring or the shock absorber and is configured to cooperate with the nut-engaging member. Optionally, the nut-engaging member includes a closed end disposed adjacent the handle and an open end disposed away from the closed end, where the open end is configured to allow placement of the nut-engaging member over the shock absorber to facilitate

engagement of the nut-engaging member and the shock absorber adjustment nut. As discussed in conjunction with the previous aspects, at least a portion of the nut-engaging member defines a race such that pawls on the ratcheting mechanism form at least a portion of the race. The nut may include a plurality of teeth disposed around its outer surface such that they can engage the pawls to make the nut rotatably responsive to rotation of the wrench. Since the nut generally stays on the shock absorber, there is an incentive to reduce its weight (especially for racing applications). Accordingly, the nut can be made from a lightweight material that is an alternate to steel, such as aluminum or an aluminum alloy, or even a nonmetal. To provide a hard, corrosion-resistant surface, the nut may include a conversion coating, plating or other protective coating. For example, the nut may be anodized. One or more bores can be formed in the nut, while a securing member (such as a screw) can be threaded into the bore to inhibit the tendency of the nut to come loose due to vibration or the like. A block can be inserted into the bore prior to the securing member. As with the previous aspects, a hinge may be disposed between the nut-engaging member and the handle to facilitate pivotal movement between them.

[0011] According to still another aspect of the invention, a shock absorber adjusting assembly is disclosed. The assembly includes a wrench and an adapter ring. The wrench includes a handle, an engaging member coupled to the handle, and a ratcheting mechanism cooperative with the engaging member. The adapter ring can be used to couple the engaging member to a nut disposed on a shock absorber, and further can be removably disposed in the engaging member. Optionally, the engaging member includes a closed end disposed adjacent the handle and an open end disposed away from the closed end. The open end is configured to allow placement of the engaging member and the adapter ring over the shock absorber to facilitate engagement of the adapter ring and the nut. At least a portion of the engaging member may

define a race such that pawls making up the ratcheting mechanism form at least a portion of such race. The adapter ring may include a plurality of teeth disposed peripherally around its outer surface. As previously discussed, the teeth of the adapter ring can engage the pawls to make the adapter ring rotatably responsive to rotation of the wrench. Also as previously discussed, numerous detents projecting from the adapter ring can be included. These detents are substantially alignable with corresponding slots in the nut such that the nut is rotatably responsive to rotation of the adapter ring. Moreover, at least a portion of the plurality of detents define an aperture therein. A securing pin, bolt or screw may also be included, where the pin, bolt or screw is disposable in the aperture and the nut, thereby preserving the rotatable relationship between the adapter ring and the nut. As discussed in conjunction with at least one of the previous aspects, the teeth on the outer surface of the adapter ring can be spaced a predetermined distance apart, such as substantially four degrees apart. The shock absorber adjusting assembly may further include at least one thrust bearing disposed against the spring of the shock absorber. In one form, the thrust bearing acts as an axial spacer between the springs of the shock absorber and the nut. For example, the thrust bearing can be placed between the spring perch adjustment nut and the spring to facilitate spring end misalignment, reduce turning friction, or both. In circumstances where a dedicated shock absorber spring perch adjustment nut is used instead of an adapter ring, the thrust bearing can be placed between the nut and the spring, or can be incorporated as an integral unit.

[0012] According to another aspect of the invention, a method of using a shock absorber adjusting device is disclosed. The method includes arranging a shock absorber system to include a shock absorber adjustment nut that is configured to facilitate adjustment of at least one of a spring or shock absorber making up the shock absorber system, configuring a shock absorber

adjusting device to comprise a handle, head and ratcheting mechanism as previously discussed, coupling the device to the shock absorber adjustment nut and ratcheting the device to effect an adjustment to the shock absorber adjustment nut. Optionally, an adapter ring can be placed between the shock absorber adjustment nut and the engaging member to facilitate coupling between them, as can one or more thrust bearings. The device can be further configured to include a hinge disposed between the head and the handle to facilitate pivotal movement between them. In yet another option, the head of the device can be configured to include a closed end disposed adjacent a distal end of the handle and an open end disposed away from the closed end, the open end configured to allow placement of the device over the shock absorber system to facilitate engagement of the device and the shock absorber adjustment nut.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0013] The following detailed description of the preferred embodiments of the present invention can be best understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

[0014] FIG. 1 illustrates a coil-over shock system and an adjustment device according to the prior art;

[0015] FIG. 2 illustrates a shock absorber adjusting device according to an aspect of the present invention;

[0016] FIG. 3A illustrates the wrench portion of the device of FIG. 2 in a first non-articulated position;

[0017] FIG. 3B illustrates the wrench of FIG. 2 in a second, articulated, position;

[0018] FIG. 4A illustrates a perspective view of the underside of the wrench of FIG. 2;

[0019] FIG. 4B illustrates the wrench of FIG. 4A engaging a shock absorber system;

[0020] FIG. 5A illustrates a illustrates another perspective view of the wrench of FIG. 2;

[0021] FIG. 5B illustrates the wrench of FIG. 5A engaging a shock absorber system;

[0022] FIG. 6 illustrates adjustment of a shock absorber system while the system is mounted to a vehicular suspension system;

[0023] FIG. 7 illustrates one embodiment of a shock absorber adjustment nut that can be used with the present invention;

[0024] FIG. 8A illustrates another embodiment of a shock absorber adjustment nut that can be used as part of the present invention; and

[0025] FIG. 8B illustrates how the shock absorber adjustment nut of FIG. 8A can be secured using a securing member.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Referring first to FIG. 1, a shock absorber system **1** and a spanner **30** according to the prior art is disclosed. In particular, a coil-over-shock system is shown, where a shock absorber **10** has a coiled spring **20** wound around it. Shock absorber **10** includes a body **12** and a piston rod **14** with an internal piston (not shown) disposed inside body **12**. The body **12** of piston **10** is threaded with threads **16**. A fluid port (not shown) is also included to allow the insertion and removal of pressurized (typically inert) shock absorber gas. Spring perches **22, 24** are placed at opposing axial ends of the spring **20**, where lower spring perch **22** is secured to the piston rod **14** and the upper spring perch **24** is secured on one side to the shock absorber body **12** and on the other to a shock absorber adjustment nut **40** the latter of which is threadably engaged with threads **16** of the shock absorber body **12** to keep the spring **20** compressed at a preferred level. Spanner **30** with nut-engaging portion **31** (including pawl **32**) is used to either tighten or loosen the shock absorber adjustment nut **40**. The shock absorber adjustment nut **40** includes on a

radially-outward portion of its outer surface a plurality of periodically spaced slots **44** (typically every sixty degrees) on the outer periphery. The slots **44** are configured to accept a pawl **32** on spanner **30**, thereby facilitating tightening or loosening of shock absorber adjustment nut **40** and the spring **20** and shock absorber **10** restrained thereby. The spacing between pawl **32** and the remainder of the nut-engaging portion **31** is fixed, and both of these are fixed relative to the fixed handle of spanner **30**. By having the slots **44** spaced every sixty degrees as shown, the spanner **30** must cover one-sixth of a complete rotation before the user can reach the next engagement position. While this may not be problematic in an easily-accessible environment, it can become difficult or impossible in confined spaces (such as the region around an automotive shock absorber system) where room to rotate the nut-engaging portion **31** of the spanner **30** is limited.

[0027] Referring next to FIGS. 2, 7, 8A and 8B, a shock absorber adjusting device **100** according to an aspect of the present invention is shown. The device **100** includes a wrench **130** with a handle **131** with a proximal end **131A** and a distal end **131B**. The wrench **130** also has a head **132** coupled to the distal end **131B** of handle **131**, and defines an engaging member **133** that can be used to couple to adapter ring **135** or directly to the shock absorber adjustment nut **140** shown in FIG. 8A. Ratcheting mechanism **134** fits within head **132**, being secured thereto by a cover **134B** and screws **134C**. Ratcheting mechanism **134** is reversible by switch **134D**, which pivots ratcheting mechanism **134** to allow one of two sets of pawls **134A** to engage complementary teeth **135A**, **140A** on adapter ring **135** or shock absorber adjustment nut **140**, respectively. In a preferred (although not necessary) embodiment, there are ninety teeth **135A** on adapter ring **135** or shock absorber adjustment nut **140**, thus giving a ratcheting angle of four degrees per pawl click. Rather than have the entire head **132** define a closed surface, the open configuration permits easier access to either shock absorber adjustment nut **40**, **140**, especially in

situations where the size of the head does not permit an aperture that would otherwise be defined within the engaging member to be placed over the shock absorber. The hinge **137** promotes additional wrench **130** adjustability, which allows the user additional degrees of freedom when trying to maneuver the wrench **130** in tight spaces.

[0028] Referring with particularity to FIGS. 8A and 8B, device **100** may be configured such that the separate adapter ring **135** of FIG. 2 is not needed. In this embodiment, shock absorber adjustment nut **140** can be placed on threads **16** of shock absorber **10** such that it directly engages with the engaging member **133** of wrench **130**. Nut **140** defines a continuous arrangement of teeth **140A** that are sized to accommodate the pawls **134A** disposed on the race **133A** of engaging member **133**. Nut **140** includes threads **140B** that can engage complementary threads **16** on the shock absorber **10**. Nut **140**, which remains attached to the shock absorber system **1**, will out of necessity be of a size to properly engage shock absorber **10**. Accordingly, its outer dimension may vary depending on the vehicle and shock absorber system **1** to which it is coupled. To accommodate this, the engaging member **133** of wrench **130** may be made in corresponding sizes to accept nuts of differing sizes. In this way, a particular wrench **130** will always be of appropriate size for a nut **140** to which it corresponds. Nut **140** may form a part of a shock absorber adjusting assembly, in which it can be used as an aftermarket replacement for factory-equipped shock absorber adjustment nuts, or it may be part of the factory-equipped shock absorber system. In either event, the teeth **140A** and outer dimensions are such that the nut **140** may directly engage the engaging member **133** of wrench **130**. Referring with particularity to FIG. 8B, nut **140** may include one or more bores **140C** angularly disposed in the nut **140** such that the nut **140** can accept a securing member **136** into the bore **140C**, thereby providing enhanced securing of nut **140** to the shock absorber body (not presently shown). Securing

member **136** (now preferably in the form of a screw, such as an allen screw) may further include a block **136A** (made of a relatively compliant material, such as nylon) that can minimize the risk of damaging threads on the shock absorber body in the event the securing member **136** is over-tightened. In addition, by virtue of its relative soft nature, the block **136A** can conform to the shape of the shock absorber threads as it is forced against them. The presence of the securing member **136** holding the nut **140** helps prevent the nut **140** from being shaken loose due to vibration and related loads on the shock absorber system.

[0029] Referring with particularity to FIG. 7 in conjunction with FIG. 2, while device **100** may be configured to engage directly with nut **140**, as discussed above, it may also include adapter ring **135** in configurations where nut **40** is used to secure the spring perch. Unlike the nut **140** shown in FIG. 8A, nut **40** has keyed slots **44** formed about its periphery to engage detents **135B** on adapter ring **135**. As with threads **140B** of nut **140**, nut **40** includes threads **46** that can engage complementary threads **16** on the shock absorber **10**. It will be understood that the outer diameter of nut **140** and nut **40** are compatible. Adapter ring **135** is sized to fit within engaging member **133** such that it can rotate along curvilinear race **133A** formed within engaging member **133**. Downwardly-projecting detents **135B** are used to engage reciprocal slots **44** formed in shock absorber adjustment nut **40**. In order to keep commonality with many of the nuts presently on the market, the detents **135B** total six in number, and are spaced sixty degrees apart, giving the adapter ring **135** as crown or castellated structure. The adapter ring **135** fits within engaging member **133** such that it will stay in place when being placed onto the shock absorber adjustment nut **40**, but loose enough that they will be easy to separate by hand. The adapter ring **135** can be defined by either a continuous, one-piece construction, or a multi-piece split construction with lines of separation **135D** between opposing halves as shown. This split

construction allows the complementary halves to be assembled together once they have been put in place onto shock absorber adjustment nut **40**. Apertures **135C** can be placed in detents **135B** and sized to accept a securing member **136** (which may be in the form of a pin, bolt or screw) such that adapter ring **135** can be at least temporarily affixed to shock absorber adjustment nut **40**. It will be appreciated by those skilled in the art that lines of separation **135D** can form a simple divide or a more intricate interlocking fit.

[0030] Referring next to FIGS. 4A, 4B, 5A and 5B, lower and upper views of the coupling of wrench **130** to a shock absorber system **1** to effect adjustment of the system is shown. Referring with particularity to FIG. 4A, the shape of race **133A** and the position of pawls **134A** (both within head **132**) are shown. As shown in the figure, a significant portion of race **133A** defines a curvilinear path to form a relatively tight fit with the cylindrical outer dimension of either shock absorber adjustment nut **140** or adapter ring **135**. Referring with particularity to FIG. 4B, the wrench **130** is shown in an engagement position, where a shock absorber adjustment nut (for example, one of nuts **40** or **140** from FIGS. 7, 8A and 8B) is situated above spring perch **24**, but hidden in the present view. Washer-like bearings **160** may be placed between the spring perch **24** and the shock absorber adjusting nut **40, 140**. Referring with particularity to FIG. 5A, the partial projection of pawls **134A** into the race **133A** can be seen; such projection helps to ensure fit between the wrench **130** and either shock absorber adjustment nut **140** or adapter ring **135**. As can be seen in both FIGS. 4A and 5A, the open-ended construction of the engaging portion **133** promotes a secure fit between head **132** and the corresponding part on the shock absorber system **1**, especially in situations where interference from connectors or other ancillary components is a possibility. Referring with particularity to FIG. 5B, the wrench **130** is shown in an engagement position with shock absorber adjustment nut **140**, where a portion of teeth **140A**

are visible through the open end of engaging member **133**. As previously discussed, if nut **40** from FIG. 7 is used, then adapter ring **135** (not presently shown) would couple wrench **130** to nut **40**.

[0031] Referring next to FIG. 6, application of one embodiment of the device of the present invention in the relatively cramped confines of an automotive application is shown. In the present figure, the variant with adapter ring **135** is shown. The pivoting relationship between the handle **131** and head **132**, made possible by hinge **137**, facilitates insertion of wrench **130** through tortuous paths to enable engagement with the nut **40** of the shock absorber system. While the device **100** disclosed is particularly applicable to shock absorber systems used in vehicular racing, it will be appreciated by those skilled in the art that it is not limited to racing applications, as any situation requiring adjustment of such a nut would benefit equally from use with the disclosed device.

[0032] Having described the invention in detail and by reference to preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the appended claims. More specifically, although some aspects of the present invention are identified herein as preferred or particularly advantageous, it is contemplated that the present invention is not necessarily limited to these preferred aspects of the invention.

[0033] What is claimed is: